Specification

Title of the Invention

Information Search/Presentation System

5   Background of the Invention

         The present invention relates to an
information search/presentation system for providing a
3D stereoscopic image at a point desired by a user and
information about landmarks in the image.

10   General methods of performing Web page search
on the WWW (Word Wide Web) and page search based on
portable telephone information providing services
include a method of sequentially selecting menus created
in advance and tracing links to destination pages. A

15   characteristic feature of these search methods is that
pages are independently searched out regardless of
physical positions. If, for example, a user searches
for information about flower shops, hit pages about
flower shops in Tokyo, Paris, New York, and the like are

20   presented regardless of the positions at which they
actually exist.

         The above search method is convenient when
locations are insignificant. If, however, a user is
standing in front of a station X in Tokyo and wants to

25   find a nearby flower shop, he/she requires only pages
about flower shops near the station. In this case, the
conventional search method, by which even pages about

- 1 -

flower shops in Paris and New York are searched out, is
inconvenient.

A method of solving this problem has been
proposed, in which when 2D map information is presented
to a user, and the user designates a certain place on
the presented map, shop information is presented by
automatically tracing a link to the shop information
located at the designated place. Such a method is
generally available and includes, for example, a method
in which when a country map is presented to a user and
the user designates a certain prefecture in the
presented map, a jump is made to information about the
prefecture.

For example, on the home page of the French
Government Tourist Office, when a user clicks a certain
prefecture in a displayed map of France with a mouse, a
jump is made to information about the prefecture. This
method can be easily implemented on the Web by using a
clickable map technique, and hence is frequently used.
Japanese Patent Laid-Open No. 9-34902 discloses an
advertisement information providing system for providing
information at a link destination as advertisement
information, which is applied to a 2D map.

The following problems are posed in the method
of accepting an input from a user upon presentation of
2D map information. First, it takes considerable effort
to update map information. In an urban area, in

particular, reconstruction of buildings, construction of new roads, and the like are often made. It requires tremendous work to maintain and update corresponding map information so as to quickly reflect the above

5   situations in the map information. Second, a search for information from a map is convenient as a search operation, but is not fun for a user. This is because a search from a map is cumbersome operation like a search for a station on a route from a timetable.

10   Summary of the Invention

It is an object of the present invention to provide an information search/presentation system which can reduce the work load required to maintain and update map information.

15   It is another object of the present invention to provide an information search/presentation system which can provide visual effects that allow a user to enjoy using the system.

In order to achieve the above objects,

20   according to the present invention, there is provided an information search/presentation system comprising a 3D image converter for outputting 3D image data on the basis of a plurality of aerial photographs obtained by photographing a single area from different places, with

25   a physical position of the area being specified, a first database for storing a pair of a verbal expression and position information as a unit record, the verbal

expression pertaining to a name and contents of a landmark existing in the area photographed to obtain the aerial photographs, a search engine for outputting link information for page data including associated contents from a set of page data on public view in response to an input keyword, and an 3D image browser for creating a 3D stereoscopic image viewed from a viewpoint position designated by a user on the basis of the 3D image data from the 3D image converter and the viewpoint position, presenting the image to the user, looking up the first database in accordance with an associated information presentation request associated with the position designated by the user, and, if a landmark corresponding to the designated position exists, outputting to the search engine a verbal expression pertaining to a name and contents of the corresponding landmark as a keyword to present a search result obtained by the search engine.

Brief Description of the Drawings

Fig. 1 is a block diagram showing an information search/presentation system according to the first embodiment of the present invention;

Fig. 2 is a block diagram showing an information search/presentation system according to the second embodiment of the present invention;

Fig. 3 is a block diagram showing an information search/presentation system according to the third embodiment of the present invention;

- 4 -

Fig. 4 is a flow chart showing the processing performed by a 3D image browser in Fig. 1;

Fig. 5 is a view for explaining the schematic operation of the information search/presentation system in Fig. 1;

Fig. 6 is a view for explaining the schematic operation of the information search/presentation system in Fig. 1;

Fig. 7 is a view for explaining the schematic operation of the information search/presentation system in Fig. 1; and

Fig. 8A and 8B are views showing 3D stereoscopic expressions viewed from different viewpoints.

Description of the Preferred Embodiments

The embodiments of the present invention will be described below with reference to the accompanying drawings.

Fig. 1 shows an information search/presentation system according to the first embodiment of the present invention. The information search/presentation system according to this embodiment is comprised of a 3D image converter 1 for inputting aerial photographs, a landmark database 2 in which information about the positions of landmarks is stored, a search engine 3 for searching for link information in accordance with keywords, and a 3D image browser 4 for

outputting a 3D stereoscopic image expression, accessing
the landmark database 2, and outputting the search
result obtained by the search engine 3 on the basis of
the 3D image data output from the 3D image converter 1
5   and input information (a viewpoint position and
information presentation instruction) from a user.

The 3D image converter 1 receives a plurality
of aerial photographs obtained by photographing a single
area from different places, with the physical position
10   of the area being specified, converts these photographs
into 3D image data by a stereo process, and outputs the
data. As a method for this stereo process, a known
technique, for example, the technique disclosed in
"Segmentation of Urban Scene from Aerial Stereo Imagery",
15   Proceedings of International Conference of Pattern
Recognition, pp. 1404 - 1407, 1998 (reference 1) or
"Extracting Buildings from Aerial Images Using
Hierarchical Aggregation in 2D and 3D", Computer Vision
and Image Understanding, Vol. 72, No. 2, pp. 185 - 203,
20   November 1998 (reference 2) can be used, and hence a
description thereof will be omitted.

The landmark database 2 is a database in which
a pair of position information and a verbal expression
pertaining to the name and contents of each landmark
25   (sign) existing in an area photographed as aerial
photographs are stored as a unit record. As a verbal
expression, a keyword sequence that the search engine 3

- 6 -

can input is used. As a latitude/longitude expression,
a 2D array expression that the 3D image browser 4 can
accept is used. A storage medium serving as the
landmark database 2 may take a relational database form

5   or general file form, and is not specifically limited.

When the user inputs a keyword sequence, the
search engine 3 returns link information for page data
including information associated with the input keyword
sequence from a set of page data on public view like the

10 WWW or the like. In the case of the WWW, widely used
search engines (e.g., "Altavista" and "Infoseek") may be
used. In the case of a portable telephone information
providing service, a search engine dedicated to the
service can be used.

15   The 3D image browser 4 includes a 3D image
creation section 41 for creating a 3D stereoscopic image
viewed from a specific viewpoint position input by the
user on the basis of the 3D image data output from the
3D image converter 1 and the viewpoint position, and

20 presenting the image to the user, a database access
section 42 for looking up the landmark database 2 upon
reception of a request to present information associated
with a specific position on a 3D stereoscopic image from
the user, a search control section 43 for, when it is

25 determined on the basis of the access result that there
is a landmark corresponding to the specific position,
transferring a verbal expression pertaining to the name

- 7 -

and contents of the corresponding landmark to the search
engine 3, receiving the search result from the search
engine 3, and presenting it to the user, and a memory 44
for storing the 3D image data from the 3D image

5   converter 1.

Fig. 4 shows the flow of processing performed
by the 3D image browser 4. The 3D image browser 4
receives 3D image data from the 3D image converter 1 and
stores it in the memory 44 (step S101). The flow then

10 shifts to the step of waiting for an instruction from
the user (step S102). Upon receiving a specific
viewpoint position from the user, the 3D image creation
section 41 creates a 3D stereoscopic image viewed from
the viewpoint position and presents it to the user (step

15 S103). After the presentation, the flow returns to step
S102 to wait for an instruction from the user.

If it is determined in step S102 that the user
has generated a request to present information about a
designated position in the 3D stereoscopic image, the

20 database access section 42 looks up the landmark
database 2 to check whether there is a landmark
corresponding to the designated position (step S104).
If no landmark is present, the user is notified that
there is no information associated with the designated

25 position (step S105). The flow then returns to step
S102.

If there is a landmark, the search control

section 43 transfers a verbal expression pertaining to the name and contents of the corresponding landmark to the search engine 3 (step S106). The search engine 3 performs search operation by using the received verbal expression pertaining to the name and contents of the landmark as a keyword. For example, one of the typical search engines on the WWW returns link information of a home page on the WWW which is associated with the received verbal expression, as a search result, to the search control section 43.

If no search result is obtained by the search engine 3, the search control section 43 notifies the user of the corresponding information (step S107), and the flow returns to step S102. If a search result is obtained, the search control section 43 presents the search result to the user (step S108), and the flow returns to step S102. As described above, if a search result is obtained, the 3D image browser 4 presents link information of a home page as the search result to the user.

The above processing in steps S104 and S105 will be described in more detail. Assume that the user is now doing aerial sight-seeing on the screen displaying the 3D stereoscopic image, and wonders, over a zoo C, "what is this structure?; it looks like a park". In this case, the user requests the 3D image browser 4 to present information associated with this position.

- 9 -

In accordance with this request, the 3D image browser 4 checks the latitude and longitude of the designated position. The 3D image browser 4 then looks up the landmark database 2 in accordance with the latitude and

5   longitude of the designated position to check whether there is a record including the position represented by the latitude and longitude. If there is no corresponding record, the 3D image browser 4 notifies the user of information indicating "there is no

10 associated information". If a corresponding record is present but no landmark is present in the record, the 3D image browser 4 notifies the user of information indicating that there is no associated landmark.

        The schematic operation of the information

15 search/presentation system in Fig. 1 will be described next with reference to Fig. 5 to 7. First of all, a single area is photographed periodically, e.g., on a weekly basis, by using an airplane or satellite. In this case, such a photograph will be referred to as an

20 aerial photograph. For example, aerial photographs taken by the Space Imaging's "IKONOS" satellite can be purchased at a cost of several thousand yen per kilometer square (monochrome). Since "IKONOS" can photograph the entire earth, a latest aerial photograph

25 of the surface of the earth can be purchased on a weekly basis. Since accurate latitude/longitude information is attached to such an aerial photograph, a specific

photographed cite can be accurately known.

As shown in Fig. 5, a stereo process is performed for two aerial photographs 50A and 50B obtained by photographing a single area from different angles, and calculations in the height direction, e.g., calculations for buildings and mountains, are performed on the basis of the differences between the two photographs. In the stereo process, information indicating which is a building and which is a mountain cannot be extracted from aerial photographs. In the stereo process, only height information at a unit point can be calculated. For example, with photographs taken by an airplane capable of low-altitude flight, height calculations can be made on the surface of the earth on a 25-cm square basis. With photographs taken by "IKONOS", height calculations can be made on the surface of the earth on a 1-m square basis because the photographs are taken at much higher altitudes.

With this processing, an intermediate expression 51 like a hedgehog is obtained. A case where height information is calculated on a 1-m square basis will be described. Consider a building with a height of 30 m in a 20-m square area. A height of 30 m is calculated at 400 (20 x 20) points within the building area. If a level ground surrounds the building, a height of 0 m is calculated at points other than those in the building area. According to the rule

- 11 -

"continuation of points at the same height indicates one
building", it can be estimated that a building exists in
this 20 x 20 area. This is a series of operations in
the stereo process.

5   The stereo process performed by the 3D image
converter 1 is an established technique, as disclosed in
reference 1. The present invention may use some proper
existing stereo process for the creation of 3D image
data, and is not limited to any specific stereo process.

10   In addition, in the present invention, the 3D image
converter 1 is described as a constituting element for
performing a stereo process, but will not be described
in more detail. When the stereo process is performed,
so-called landmarks such as a building and mountain are

15   extracted. In the present invention, such data will be
referred to as 3D image data 52. Since accurate
position information about a reference point in an
aerial photograph is attached to the photograph,
position information about each landmark can be easily

20   calculated from the distances from the reference points
on the x- an y-axes.

           A 3D stereoscopic expression 53 is created by
using the 3D image data 52, as shown in Fig. 6, and
presented to the user. In this case, a viewpoint

25   position from which the user views is provided for the
3D stereoscopic expression 53. As the viewpoint
position changes, as shown in Fig. 8A and 8B, a 3D

stereoscopic expression 53' changes into a stereoscopic expression 53" viewed from a different position. If the viewpoint position is gradually and continuously moved, the 3D image changes from moment to moment as if the
5 user were doing a sight-seeing flight. A technique of creating the 3D stereoscopic expression 53 from the 3D image data 52 has been established as disclosed in, for example, "Automatic generation of high resolution urban zone digital elevation models", ISPRS Journal of
10 Photogrammetry & Remote sensing, pp. 33 - 47, 1997 (reference 2). The present invention only uses such a 3D stereoscopic image creation technique.

Assume that the user designates a specific landmark and generates a request to present associated
15 information during a "sight-seeing flight" in the 3D stereoscopic expression 53. In this case, it is convenient if information associated with the landmark is presented on the Internet. A database 54 is a table in which verbal expressions or keyword sequences
20 indicating the names and contents of landmarks such as buildings are stored in correspondence with position information indicating the locations of the landmarks. If, for example, a landmark is an international exhibition hall A, keywords such as the "full name",
25 "abbreviation", and "address" of the international exhibition hall A are stored in advance. If the landmark is a museum B, the "full name", "special

exhibition name", "address", and the like of the museum
B are stored in advance.

        If the user generates a request to present
information associated with a specific landmark, the
5   database 54 is looked up in accordance with the position
of the landmark. If the corresponding landmark is
stored in the database 54, a verbal expression or
keyword sequence representing the name and contents of
the landmark is transferred to the search engine 3 for
10 the WWW on the Internet. The search result obtained by
the search engine 3 is presented as associated
information to the user. A search engine to be used may
be a general search engine. However, information can be
presented more properly by using a search engine capable
15 of performing more intellectual processing for position
information and address information. The user can
obtain information associated with the desired landmark
from general Web contents 55 on the basis of the link
information obtained as the search result.

20   As described above, according to the present
invention, the above two problems can be solved by
receiving an input from the user upon presenting map
information, and presenting associated information to
the user. With regard to the first problem that it
25 takes considerable effort to update map information,
since manual operation of creating a map can be replaced
with mechanical operation by using artificial satellite

- 14 -

images or aerial photographs, map information can be easily updated. If, for example, "IKONOS" is used, image information about the entire surface of the earth can be updated weekly. This makes it possible to
5   present, for example, a scene in which a field that was entirely covered with snow last week has changed to a green field this week. In addition, the condition of a mountain that changes on a weekly basis in the fall can be presented timely. Likewise, changes in weather and
10   condition of a volcanic eruption can be easily informed every day.

In addition, according to the present invention, updated latest information associated with a map can be presented when the user requires it, because
15   a search for information is made independently of the map. For example, weather information and information about volcanoes are presented and updated on the WWW, and hence such latest information can be used when required. According to the conventional method, since
20   associated information is attached to a map in advance, the information must be manually updated to present latest information. This is not practical method in consideration of actual operation. The present invention solves this problem and can always present
25   latest information to the user.

According to the present invention, the second problem that a search for information from a map is not

fun for the user can be solved by allowing the user to change a 3D stereoscopic image in real time by changing input information about a viewpoint position. With this operation, the user feels as if he were doing a

5　　sight-seeing flight, thus obtaining a visual effect that makes the information search much more fun for the user than when the user simply traces on a 2D map. In addition, as described above, when the user sees a given area, the above technique can express, for example, a

10　　scene in which a field that was entirely covered with snow last week has changed to a green field this week with a sense of realism. This further gives the user a lot of pleasure.

　　　　　Fig. 2 shows an information

15　　search/presentation system according to the second embodiment of the present invention. The same reference numerals as in Fig. 1 denote the same parts in Fig. 2, and a description thereof will be omitted. In addition to a 3D image converter 1, landmark database 2, search

20　　engine 3, and 3D image browser 4, the information search/presentation system of this embodiment includes a user position display unit 12 for displaying a user position on the basis of the 3D stereoscopic image expression output from the 3D image browser 4, a

25　　threshold indicating the maximum number of other users, and the viewpoint position information of the user, a user database 11 for outputting the viewpoint position

information of the user to the user position display
unit 12, a time storage section 14 for outputting the
maximum number of other users to the user position
display unit 12, and an interaction connection section
5   13 for performing interaction connection with another
person desired by the user.

　　　　The user database 11 stores the current
viewpoint position information of all users who are
currently logging in to the system. When an information
10 search service using the present invention is to be
provided by using the WWW, it is natural that the user
database 11 is realized by a relational database. Each
user performs a sight-seeing flight on a WWW browser and
inputs the current viewpoint position to the WWW browser.
15 This input is transferred to the WWW server and stored
in the user database 11 in the relational database from
moment to moment.

　　　　The user position display unit 12 adds a user
position mark indicating the current position of the
20 user to the viewpoint position designated by the user on
the 3D stereoscopic image presented to the user by the
3D image browser 4. Subsequently, the viewpoint
positions of other users from the user database 11, and
other user position marks indicating the current
25 positions of the other users are displayed at the
respective viewpoint locations.

　　　　It is natural that the user position display

unit 12 is realized as an additional function on the WWW browser. In general, this function is realized by a Java applet, ActiveX, or plug-in function. The viewpoint position of the user can be acquired on the WWW browser side. However, when the current position of distant user is to be acquired, the user must issue a request to the WWW server to acquire the current position of a distant user from the user database 11. If an area where the user is to do a sight-seeing flight is as narrow as 1 kilometer square or the total number of users is small, no problem arises in acquiring all the current positions of other users. If, however, the range of a sight-seeing flight covers the entire world or the number of users is very large, only the current positions of other users are returned up to the maximum number of other users stored in the time storage section 14 in the increasing order of distance from the user himself/herself.

When the user designates a specific distant user position mark and generates a request for interaction, the interaction connection section 13 establishes connection for electronic mail, telephone, or chat function with the designated distant user. More specifically, when the user designates a specific distant user mark on the WWW browser, the interaction connection section 13 notifies the WWW server side of the reception of the interaction request, and checks the

ID of the distant user. The interaction connection
section 13 activates an execution application for a
predetermined interaction means such as electronic mail,
telephone, or chat function to establish connection.

5   Whether an interaction is made or rejected on
the distant side is determined in the activated
execution application, and hence this processing falls
outside the range of the present invention.

          According to the second embodiment, since the
10   user can see what a distant user is seeing in a
sight-seeing flight, the user can know what kind of
person is "roaming" what kind of place. This further
gives the user a lot of pleasure. Users who are seeing
the same place may visit noted places of historic
15   associations or get acquainted with each other as the
saying goes "good company makes the road shorter".
Assume that the user is seeing a place around the
Leonardo Da Vinci Museum at Vinci on the outskirts of
Florence in Italy. In this case, another person may
20   appear in this place. In such a case, the user may
expect that the person also likes Leonardo Da Vinci, and
they may call to each other to start friendship.

          Fig. 3 shows an information
search/presentation system according to the third
25   embodiment of the present invention. The same reference
numerals as in Fig. 1 denote the same parts in Fig. 3,
and a description thereof will be omitted. In addition

- 19 -

to a 3D image converter 1, landmark database 2, search
engine 3, and 3D image browser 4, the information
search/presentation system of this embodiment includes a
movement log retention section 21 for retaining all
5   movement logs output from the 3D image browser 4, a
distance storage section 22 for storing a distance that
indicates the range of a landmark area in advance, a
time storage section 23 for storing a threshold of a
stay duration (flight duration) in advance, a stay
10   duration calculation section 24 for calculating a stay
duration (flight duration) in a landmark area on the
basis of outputs from the distance storage section 22
and time storage section 23, a stay landmark
determination section 25 for determining a landmark at
15   which the user is staying and doing sight-seeing on the
basis of outputs from the movement log retention section
21 and stay duration calculation section 24, a user
database 26 for storing landmark stay information about
the user and adds data from the stay landmark
20   determination section 25 as database information, an
instruction log retention section 27 for retaining all
information search instruction logs output from the 3D
image browser 4, and a presentation section 28 for
presenting a research totalizing result on the basis of
25   outputs from the user database 26 and instruction log
retention section 27.

         The movement log retention section 21 records

- 20 -

a pair of the viewpoint position of the user and the corresponding time as a movement log. The distance storage section 22 stores a predetermined radius defining a circle centered on a specific landmark, which is used to determine whether the user is interested in the landmark. Assume that a numerical value of 500 m is stored in the distance storage section 22. In this case, if the user enters a radius of 500 m of a circle centered on a given landmark, it is determined that the user is interested in the landmark.

The time storage section 23 stores a minimum stay duration in which the user stays around a specific landmark in advance, which is used to determine whether the user is interested in the landmark. Assume that a numerical value of 1 min is stored in the time storage section 23. In this case, if the user stays around a given landmark for 1 min or more, it is determined that the user is interested in the landmark. The stay duration calculation section 24 looks up the landmark database 2 to extract the position of a landmark over which the user passed and the time when the user passed over the landmark from the movement logs retained in the movement log retention section 21. The stay duration calculation section 24 calculates the first and last times at which the user is located within the distance range stored in the distance storage section 22 at positions before and after the extracted landmark.

The stay landmark determination section 25 compares the threshold stored in the time storage section 23 with the difference between the first and last times (the stay duration in a predetermined landmark area) calculated by the stay duration calculation section 24. If the difference is equal to or larger than the threshold, it is determined that the user has stayed in the landmark area, and a pair of the landmark name and the difference between the last and first times are added as a unit record to the user database 26. The user database 26 stores the landmarks at which the user has stayed and the stay durations in pairs (landmark stay information).

The instruction log retention section 27 records an information presentation instruction log by recording a pair of the name of a landmark for which the user has issued an instruction to present associated information and the instruction time as a unit record. Upon reception of an instruction to present a totalizing result from a manager, the presentation section 28 outputs all the records in the user database 26 and all the records in the instruction log retention section 27.

Although the stay landmark determination section 25 calculates the difference between the last and first times calculated by the stay duration calculation section 24, i.e., the stay duration in a predetermined landmark, the stay duration calculation

section 24 may calculate this and transfer it to the
stay landmark determination section 25.

In this arrangement, the landmark stay
information about the user is automatically stored in
the user database 26, and landmark stay information is
presented by the presentation section 28 in association
with instruction log information from the instruction
log retention section 27.

According to the third embodiment, since all
pieces of information indicating when and where each
user has visited can be recorded, pieces of information
indicating social trends, e.g., indicating what kinds of
people gather what kinds of places, can be totalized.
For example, by acquiring all pieces of information,
e.g., information indicating how many people went to see
the cherry-trees at a point B when (x month, xx day) the
cherry-trees were in full blossom and information
indicting which places people went after seeing the
cherry-trees at the point B, valuable marketing
information can be acquired.

Obviously, if the service manager side knows
where users roamed while they were identified, users'
privacy is invaded, and the users do not want to accept
it. Therefore, each user allows the manager side to use
the above information with the user's anonymity being
protected. This makes it possible for each user to use
the system with a feeling of being safe. In practice,

various search engines that are currently providing free
services on the WWW totalize such pieces of search
information and use the totalizing result as marketing
information.

5   As has been described above, according to the
present invention, when an input from a user is received
upon presentation of map information, and associated
information is presented, the above two problems can be
solved.

10   With regard to the first problem that it takes
considerable effort to update map information, manual
creation of a map can be replaced with mechanical
operation by using artificial satellite images or aerial
photographs, the map information can be easily updated.

15   With regard to the second problem that a
search for information from a map is not fun, an
illusion of a sight-seeing flight can be produced by
letting a user change his/her viewpoint position, thus
obtaining a visual effect that makes an information
20 search much more fun than when the user simply traces on
a map.